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Local perspectives on the formalization of artisanal and small-scale mining in the Madre de Dios gold fields, Peru

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ABSTRACT

A growing number of governments and donors are promoting the formalization of artisanal and small-scale mining (ASM). They believe that doing so puts them in a better position to govern the sector, and manage the social and environmental impacts of its activities. Mainstream formalization processes are based on the assumption that clear property rights enable the recipients of these rights to capitalize their possessions. Because of reciprocal obligations, the argument follows that formalized ASM actors then better embrace the social and environmental norms regulating their activity. This paper reflects critically on attempts made to formalize ASM in Madre de Dios in Peruvian Amazonia. We share local perceptions of ASM impacts, and broaden understanding of the relationship between mainstream formalization and more bottom-up processes for governing and managing ASM impacts. We forward mesoscale collaborative approaches to impact management. In Madre de Dios, this could involve the appointment of a regional mediator with a strong mandate, establishment of a mobile formalization office, and the implementation of a series of coordinated but independent impact management activities through an impact management plan. This approach would not involve a stepwise procedure in which the failure to achieve one goal would prevent the pursuit of others.

1. Introduction

Artisanal and small-scale mining (ASM) is an important source of employment and generates significant financial flows. Millions of ASM operators worldwide produce an estimated 400 t of gold annually, representing 17–20% of officially recorded production (Seccatore et al., 2014). Global mineral prices, combined with the flows of transnational capital and migratory low-cost workforces, have caused ASM activities – most of which are informal – to expand and contract in rapid cycles along mobile frontiers, often with high turnovers of people (Hammond et al., 2007; Swenson et al., 2011).

The ASM sector is also commonly associated with high social and environmental costs, including precarious working and living conditions, poor health and safety records, child labor, sexual exploitation, human trafficking, tax evasion, deforestation and pollution (e.g. Hammond et al., 2007; Hilson, 2010; Elmes et al., 2014; Vallejo Rivera, 2014). These problems have fueled the criticism of ASM, and ultimately its portrayal as a threat to the environment, to local communities, and to vulnerable societies in general. However, because of its undeniable importance as a source of employment and income, particularly for a large number of marginalized people, ASM has also been claimed to have potential to generate socially inclusive economic growth contributing to poverty reduction (Labonne, 2014).

Both of the aforementioned views are closely associated with a broader global development discourse endorsing the integration of the so-called informal sectors of national economies into formal regulatory regimes (Yusuff, 2011; Putzel et al., 2015). Formalization of ASM involves property rights resolution and enforcement, land-use planning, fiscal regulation, and, more broadly, the implementation of environmental and social norms. For governments, formalization provides a platform to better govern and

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consequently manage the social and environmental impacts of mining (i.e., to minimize its negative impacts, and to harness its positive impacts).

However, formalization schemes for ASM have been criticized for insufficiently integrating the perspective of the local mining actors (see e.g. Verbrugge and Besmanos, 2016). Indeed, it is not only a question of institutional design and rule implementation but also a matter of understanding how institutions as working rules and practices function and are received by people in particular societal and environmental circumstances. Efforts to formalize ASM are also connected with issues such as pre-existing identities and memories in particular places (Salman et al., 2015). We hold in this article that ASM formalization efforts not only usher in new working rules but also inevitably disrupt and seek to break already existing habits and practices (Hiedanpää et al., 2015). Here lies a major tension that prevents the success of formalization on the ground. On this basis, we forward our main argument: formalization processes should be seen as interconnected with impact management but the latter ought not to be considered dependent on the former.

We study attempts made to formalize ASM in the Madre de Dios region of Peru. Our empirical analysis is based on findings from three workshops we organized in Puerto Maldonado in 2015 for regional and local ASM actors. Our analysis identifies and evaluates the local stakeholder perceptions of the impacts of ASM in Madre de Dios, and presents a series of impact management measures elaborated by our workshop participants. We broaden understanding of the relationship between what we call a 'mainstream formalization' process on one hand, and the option of a more bottom-up process to govern and manage ASM impacts on the other hand.

2. 'Mainstream formalization' as policy action

Formalization of ASM is generally pursued in an attempt to gain better control of the adverse social and environmental impacts of mining (Hilson and McQuilken, 2014). Formalization processes are often reduced to registering the pre-existing customary possessions or access to resources, transforming these resources to private property and then enforcing regulations concerning rights and obligations associated with the newly formed property (Bromley, 2009; Putzel et al., 2015). Indeed, formalization processes are typically based on the assumption that establishing and enforcing property rights will empower the recipients of these rights with the opportunity to capitalize their possessions (e.g. de Soto, 2000; Siegel and Veiga, 2009). A further assumption is that because of reciprocal obligations, these actors will then abide by the norms related to the social and environmental impacts of their activities. We consider this to be 'mainstream formalization'.

However, property rights (rights to benefit streams), and rights and duties in general (political and human rights), are not necessarily linked (Bromley, 2006). Formal titles emphasized in 'mainstream formalization' processes do not guarantee successful formalization (Bromley, 2009). These kinds of formalization processes also risk becoming overwhelmingly complex and bureaucratic while, paradoxically, the more complex the processes become the more they seem to ignore the important situational aspects and informal characteristics of the mining practices they address (Damonte, 2016). The paradox appears because of the diversity of underlying resource habits and practices to be formalized. As a matter of fact, formalization can transform many informal agents to illegal agents (Geenen, 2012; Salo et al., 2013; Putzel et al., 2015) and lead not only to a policy failure and institutional 'misfit' but also to a general disillusion and frustration among the stakeholders involved.

Formalization is therefore not a straightforward technical procedure (Salo et al., 2013; Hiedanpää et al., 2015). It is rather a discursive process that always builds on the policy support of certain political ideologies, ethics, and values (Spiegel, 2012; Hilson et al., 2016). Fish, (1989) has used the concept of 'interpretative community' to explain how the inside and the outside (i.e. the underlying practice and the formalization process), respectively, are expected to interact and produce intended consequences. According to the author (p. 150): "The community [e.g., formalization apparatus], in other words, is always engaged in doing work, the work of transforming the landscape into material for its own project; but that project is then itself transformed by the very work it does". Interpretative communities are social networks whose support is essential for interventions to even appear successful (Mosse 2004; Igoe and Fortwangler, 2007).

Formalization is always a two-way learning process. It is initiated for a reason, but the underlying informal set of practices

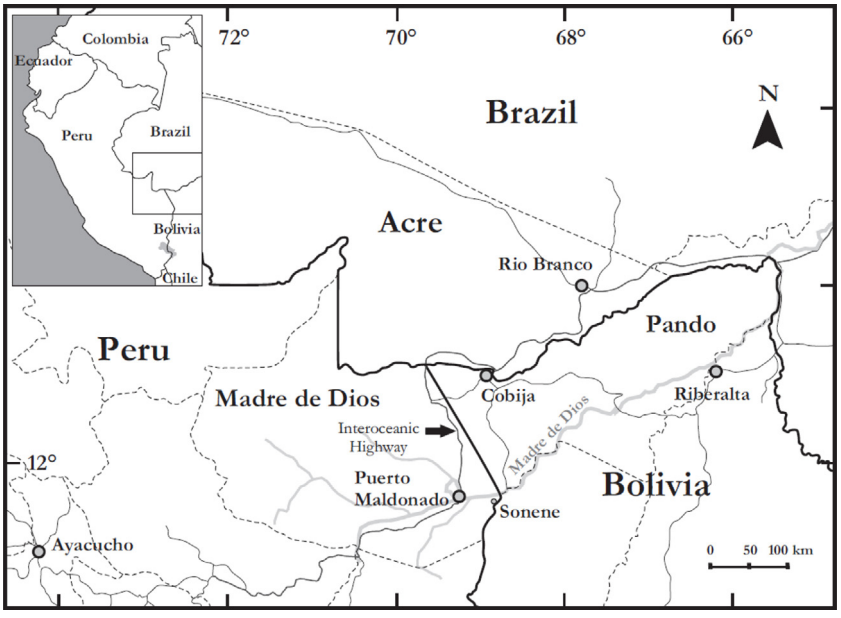

Fig. 1. The location of the study area, the region of Madre de Dios in Peruvian Amazonia.

makes formalization an uncertain and political endeavor for government, civil society, and their interpretative communities. Therefore, impact management and, especially, the elaboration and implementation of impact management plans, as Franks and Vanclay (2013) have suggested, may offer a technical and discursive means for governments and civil society actors struggling not only with the impacts of ASM but also with the trouble brought along by ongoing formalization attempts.

3. Empirical case

3.1. ASM and its formalization in Madre de Dios

Over millions of years, sediments originating in the gold bearing deposits on the eastern slopes of the Andes have been distributed by rivers across Western Amazonia. The river systems have enriched the small gold particles to coarser gravel lenses. The drifting river channels have created complex sedimentological settings under the Amazonian rainforest floor (Virtanen 2014) with rich alluvial gold deposits in and around the Madre de Dios region (Fig. 1). While gold has been exploited in this region since ancient times (Berthelot, 1986), the modern era of gold mining began in the 1930s, and the mining frontier gradually expanded through the following decades (GOREL, 2011). The first mining was artisanal, with the miners operating such basic manual tools as pickaxes, shovels and wheelbarrows. In time, however, the gold extraction processes became increasingly machinery-oriented and efficient.

The Peruvian State has contributed to the development of a modern gold rush in Madre de Dios over the last decade. First, Peruvian society as a whole is characterized by labor informality: two thirds of the working population is without access to social protection (Linares, 2010), thwarting the role of the state as a guarantor of basic rights and a regulator of working conditions. Second, as the neoliberal economic policies in place since the early 1990s have promoted mining, the governance of the sector takes place through large corporations and associated elites. Further, there are no functioning means to address ASM actors that have proliferated in Amazonia (Damonte, 2016). Third, shifting land-use policies affecting Amazonia and Madre de Dios have emphasized agricultural production and forestry (Chavez and Perz, 2013) but are lacking a focus on mining since the abolition of the National Mining Bank in 1992 (Damonte, 2016). Fourth, a political decentralization process has transferred faculties related to land-use planning from the central government to the regional governments, but without a clear recognition of the political nature of this shift (Jeronimo et al., 2015). Fifth, the Peruvian State has always seen Madre de Dios as an extractive frontier to be occupied and exploited rather than as a subject of long-term socio-economic development (Damonte, 2016).

In Madre de Dios, a low level of state involvement has coincided with high levels of investment in large-scale infrastructure construction projects, including the Interoceanic Highway connecting the coasts of Brazil and Peru (Swenson et al., 2011). The improved accessibility of Madre de Dios by road has further facilitated an influx of migrants from the surrounding highland regions, leading to an unprecedented expansion of the mining frontier (Swenson et al., 2011; Asner et al., 2013; Elmes et al., 2014). At the same time, technologies used for small-scale mining there have become more advanced, displacing the former workers (Damonte et al., 2013). At least 30,000 informal miners operated in Madre de Dios in the early 2010s (Brack et al., 2011) in a region where total human population stands at about 130,000. The miners operate machinery such as bulldozers, heavy loaders, high capacity dump trucks, and dredgers of all sizes equipped with pumps varying in capacity from 18 kW to over 300 kW. Officially, the region accepts only mining that qualifies as ASM. However, miners operate informally and many have upscaled their operations, openly exceeding the criteria of magnitude set for ASM (Damonte, 2016). The miners themselves are a diverse group, including formal and informal rights holders, invited guests exploiting holdings in exchange for a royalty payment, paid workers, and individual independent miners (Damonte, 2016).

Although accurate statistics are not available because of the informal nature of ASM, it has been estimated to represent over half of the economy of the Madre de Dios region (La República, 16.9.2013, p. 10). The informal nature of ASM together with the population increase means that the different levels of government have to address the needs (e.g., healthcare, education, and security) of the people without increases in public funds. Furthermore, the mining operations and the presence of tens of thousands of miners and their associates in the gold fields generate demand for all kinds of products and services, of which many share the informal character of the mining sector itself. Such a profound and eminently informal integration of the mining sector into the regional socio-economic and political fabric has made the region without gold and miners unimaginable.

While the gold rush has generated extraordinary financial flows, it has also incurred high environmental (Swenson et al., 2011; Ashe, 2012; Yard et al., 2012; Asner et al., 2013; Alvarez-Berríos and Aide, 2015) and social costs (Vallejo Rivera, 2014). A lack of adequate spatial planning and deficient enforcement of the spatial limits of mining have contributed to the massive deforestation and degradation of the riverine landscape (Swenson et al., 2011; Asner et al., 2013). Informality also feeds crime, including human trafficking, violence, and sexual exploitation. On top of all this, gold mining contaminates the rainforest and riverine ecosystem, including the effects of mercury in the food chain up to the level of humans (Swenson et al., 2011).

These problems have led to a complex series of confrontations among different interest groups, including agencies of the Peruvian central government and the regional government of Madre de Dios, clusters of economic and political power, non-governmental organizations (NGOs), miners' associations, and indigenous organizations, as well as people making a living through tourism, agriculture, or other uses of natural resources such as Brazil nut harvest, forestry, and fishing. The Peruvian central government has sought to gain the control of the ASM activities through a nationwide process of formalization that began in 2002 with the enactment of a law specifically addressing this issue (GOREL, 2011). A simultaneous political decentralization process has entailed the transfer since 2006 of a number of responsibilities concerning the matters of mining from the central government to the regional governments.

The regional government of Madre de Dios, through its new functions in the mining sector, has approved a Formalization and Restructuring Plan for the mining sector in Madre de Dios. The plan confines mining along the Madre de Dios River and its tributaries, where a ca. 5000 km^2 "mining corridor" accommodates up to 2800 mining concessions and claims (GOREL, 2011). The formalization process has six mandatory steps: (1) the declaration of commitment to follow the process within the mining corridor, (2) accreditation of ownership of concession or contract with a concessionaire, (3) authorization for the use of land with no conflicts over rights, (4) authorization for the use of water, (5) environmental impact mitigation and correction instrument, and (6) authorization to initiate the mining operations. The actors involved in ASM have to fulfill four additional mandatory requirements, including a certificate of training, a certificate of the absence of archeological remains, an authorization for the use of explosives, and an accreditation as an ASM enterprise.

Many have entered the process, but the progress has been slow since the beginning. As of June 2014, of the ca. 5500 miners that

initiated the process through the declaration of commitment, there were only 11 actors who had completed the second step of the formalization process (Defensoría del Pueblo, 2014). According to the Regional Directorate of Energy, Mines and Hydrocarbons (DREMH) (Oyola Valencia, 2014), of the total amount of mining concessions in the mining corridor, approximately 74% were in conflict with other overlapping land-use activities, and therefore unable to complete the third step. Furthermore, of the remaining 26%, most were in the vicinity of a river or other water body, implying a prohibition to operate as dictated by the Legislative Decree No. 1100 from the year 2012. Therefore, completing the formalization process is theoretically possible only for a small fraction of the miners. As a result, by June 2016, there was still no single mining actor in Madre de Dios who would have fulfilled all the steps and requirements of the formalization process.

The central government has not been able to solve the conflicts of overlapping land-use activities and has further complicated the formalization through new regulating decrees. Meanwhile, the government response to the stalemates of the formalization process and the growing negative impacts of mining has been the adoption of a dual strategy of promoting formalization and implementing interdiction. The former features a technical-bureaucratic process, and the latter offers police operations and even military air strikes to illegal mining facilities (e.g. La República, 30.8.2013). Moreover, it seems that there is a conflict of interest between the Ministry of Environment and the Ministry of Energy and Mines. The former aims to halt mining in Madre de Dios, whereas the latter pursues formalization (Damonte, 2016).

The consequences of these problems have become apparent in the region, straining the relations between the central government and the regional authorities. The formalization process has stagnated (Damonte, 2016), with the interdiction activities becoming a synonym for state intervention. Simultaneously, a great number of mining operators are breaking the law with impunity. The situation is exacerbated by an economic downturn in the region due to the completion of the infrastructure projects and the decreased gold price. As a result, the regional authorities have insufficient resources to counter the demand for services by the mining sector. The limitations range from inadequate infrastructure to deficient budget, obsolete equipment, and lack of technical skills and personnel.

Another clear obstacle for proceeding toward better mining practices in the region is that the involved actors are either not motivated by the formalization measures or they do not have the capacity to act in accordance with the process. Moreover, the formalization process is pursued by the central and regional governments at the level of individual mining operators, while an overall strategy for the governance and management of the impacts of the ASM sector is absent.

3.2. Workshops with regional actors

We sought to investigate the perceptions of the local and regional actors in relation to the impacts of ASM and its problematic formalization efforts in Madre de Dios. To this end, we organized a series of three workshops in the city of Puerto Maldonado in March 2015. Our objective was to invite a diversity of actors with a stake in the formalization process to identify the impacts of ASM in the region, to assign the impacts of ASM a rate along an axis from positive to negative (axis "valuation"), to prioritize the urgency of action in relation to these impacts (axis "prioritization"), and to propose activities to be carried out to tackle the tasks defined. We put particular emphasis on the treatment of the impacts of the formalization process and a major purpose of the workshops was to facilitate the governance of impacts through the introduction of an impact management plan. Considering that environmental impacts have, by definition, a social character, we emphasized such impacts that directly affect people (e.g., deforestation is dealt with, not *per se*, but rather as impacting benefits obtained from forests).

We called on the participation of three main types of actors: the miners' organizations, the civil society, and the central and regional government authorities. In practice, we also left room for the judgment of the local organizations to pass the word on and we kept the workshops open to anyone representing the above mentioned three groups in one way or another. We used two methods to distribute the invitation. First, we sent a formal letter of invitation and an e-mail to a number of organizations (specified in the Supplementary material A), asking them to send their representatives to the workshops. Second, we made a personal visit to those organizations that did not respond to the letter and the e-mail.

The objective of the first workshop, organized on March 24, 2015, was to gather the different actors together to set the stage for scrutiny of the impacts of ASM and the formalization process. The 33 participants registered in the first workshop reviewed a list of 49 potential impacts of mining in Madre de Dios identified *a priori* based on, for example, the literature and documents cited in this article. Three new impacts were added to the list after a review of this list at the beginning of the workshop (Supplementary material B). The participants were then divided into four facilitated working groups, two of which included miners (groups of 7 and 9 participants), one representatives of civil society actors (6 participants) and one representatives of the authorities (11 participants). The idea was to form small groups with potentially like-minded people. This kind of enclave deliberation can facilitate an open-minded search for solutions when the participants do not need to demonstrate their strict views to others who are potentially in disagreement (Grönlund et al., 2015).

The participants then went through all the impacts mentioned in the list and rated them in relation to two different criteria. One of these was a "valuation" of the impacts, that is, whether the participants thought that a specific impact in the context of Madre de Dios was highly positive (1.00), moderately positive (0.75), neutral (0.50), moderately negative (0.25), or highly negative (0.00). Second, the participants made a "prioritization" of the impacts, that is, when it is necessary to act, the activities are required urgently (1.00), on the short term (0.75), medium term (0.50), long term (0.25), or whether there is no need to act (0.00) in relation to the specific impact (the values in parenthesis are used in Tables 1 and 2). Within the groups, the participants performed the task individually, but the facilitators encouraged discussion, explaining the task and answering any questions that arose. Nevertheless, some participants had problems with the task and either did not make all the rankings or were mistaken about the direction of the ranking scales. We have corrected the clear

Table 1
The most important positive impacts of ASM in Madre de Dios as rated (Valuation = Val. and Prioritization = Pri.) by the workshop participants in the clusters of Lower concern (Lower c.) and Higher concern (Higher c.). The two columns to the right ([d]Val. and [d]Pri.) show the difference between the ratings of the clusters (based on X-means clustering model; see details in Section 3.3). The smallest differences, indicating similar views shared by both clusters, are highlighted as gray. Ratings for all impacts are presented in the Supplementary material B.

Impact	Lower c.		Higher c.		[d]Val.	[d]Pri.
	Val.	Pri.	Val.	Pri.		
Generation of employment	1.00	0.78	0.95	0.76	0.05	0.02
G. of small and med.-sized enterpr.	0.92	0.73	0.86	0.77	0.06	0.04
Development of technologies	0.82	0.71	0.82	0.82	0.00	0.11
Strengthened presence of the state	0.81	0.60	0.77	0.87	0.04	0.26

Table 2
The most important negative impacts of ASM in Madre de Dios as rated (Valuation = Val. and Prioritization = Pri.) by the workshop participants in the clusters of Lower concern (Lower c.) and Higher concern (Higher c.). The two columns to the right ([d]Val. and [d]Pri.) show the difference between the ratings of the clusters (based on X-means clustering model, see details in Section 3.3). The smallest differences indicating similar views shared by both clusters are highlighted as gray and the largest indicating disagreement as black. Ratings for all impacts are presented in the Supplementary material B.

Impact	Lower c.		Higher c.		[d] Val.	[d] Pri.
	Val.	Pri.	Val.	Pri.		
Corruption	0.22	0.84	0.02	0.96	0.20	0.12
Alteration of water quality	0.26	0.71	0.05	0.89	0.21	0.18
Labor informality and insecurity	0.28	0.61	0.06	0.90	0.22	0.29
Absence of the state in mining areas	0.07	0.77	0.07	0.93	0.00	0.16
Alteration of landscape	0.32	0.57	0.07	0.80	0.25	0.23
Human trafficking for sexual expl.	0.37	0.37	0.07	0.87	0.30	0.50
Tax evasion	0.26	0.57	0.07	0.79	0.18	0.22
Precarious health & education serv.	0.23	0.73	0.08	0.94	0.15	0.21
Proliferation of disease	0.29	0.44	0.08	0.83	0.22	0.38
Conflict because of land-use overlap	0.12	0.78	0.09	0.94	0.03	0.16
Organized crime	0.36	0.41	0.10	0.77	0.26	0.36
Exploitation of minors	0.39	0.44	0.10	0.85	0.29	0.41
Opportunities for asset laundering	0.39	0.24	0.10	0.80	0.29	0.56
Contamination of humans by toxins	0.43	0.24	0.10	0.84	0.33	0.60
Human trafficking for labor expl.	0.45	0.20	0.10	0.85	0.35	0.65
Smuggling and shortages of fuel	0.13	0.76	0.12	0.82	0.02	0.06
Dangerous working conditions	0.39	0.33	0.12	0.86	0.27	0.53
Destruction of agricultural land	0.35	0.55	0.13	0.76	0.22	0.21
Precarious settl. and overcrowding	0.34	0.44	0.15	0.80	0.19	0.36
Invasion of public or private land	0.29	0.39	0.15	0.83	0.14	0.45
Malnutrition	0.41	0.17	0.17	0.82	0.24	0.65

mistakes of the latter type in our data. There are also some missing data points due to the participants not rating all impacts along both axes.

Before the second workshop, we calculated the mean values of the ratings by the participants and plotted the results along two axes: "valuation" and "prioritization." We did this for all data, and then separated the results for miners, authorities, and civil society actors. The resulting plots were similar to those presented in Fig. 2.

The second workshop, organized on March 26, 2015, built on the results of the first. To start, we presented a summary of the results of the first workshop to the 27 participants. Then, we divided the participants into five facilitated thematic working groups, each with the task to devise and propose activities that would either help the formalization process forward or contribute to the governance and management of the ASM impacts in the region. Each group worked on two to three such impacts of ASM that had been ranked as important in the first workshop. Each group addressed both positive and negative impacts.

In the third workshop on March 31, 2015, we organized a plenary discussion on the proposals presented in the second workshop. The 23 participants discussed the draft document that had been circulated before the event among the participants of the two first workshops.

3.3. Cluster analysis

For a deeper analysis of the data provided by the participants in the first workshop, we performed a cluster analysis to find out whether there were groups (clusters) of participants that had notably different views over the impacts and what these differences were. This was done after the third workshop. We used X-means clustering (Pelleg and Moore, 2000) to group (cluster) the participants. This, in general, is an extension of the k-means clustering algorithm in that it does not require determination of the cluster numbers *a priori*. Instead, cluster number was determined by Bayesian information criterion (BIC), where the algorithm balanced the trade-off between precision and model complexity. In pre-processing, missing data (9% and 14% of answers for the "prioritization" and "valuation" of impacts, respectively) were imputed using k-nearest neighbor algorithm (Batista and Monard, 2001) whose parameter k (range: 1, . . . , 20) was optimized within a 10-fold cross-validation loop (Kohavi, 1995). In the results section of this article, we use the results of the cluster analysis instead of the preliminary analysis performed between the first and the second workshops.

4. Workshop findings

4.1. Local perspectives on the social impacts of ASM

The analysis of the ratings highlighted the importance of a number of impacts of ASM that were considered particularly positive or negative as well as prioritized as particularly urgent to address. As expected, the participants clearly associated low levels of urgency to act with the neutrality of the impact in question. However, this did not necessarily mean that the impact as such was considered neutral, but rather that it was not linked in a relevant way to ASM in Madre de Dios or was simply considered absent in the region.

The clustering analysis showed that there were two clearly distinct clusters of participants with notably different views over the impacts of ASM in Madre de Dios. One cluster (Cluster: Lower

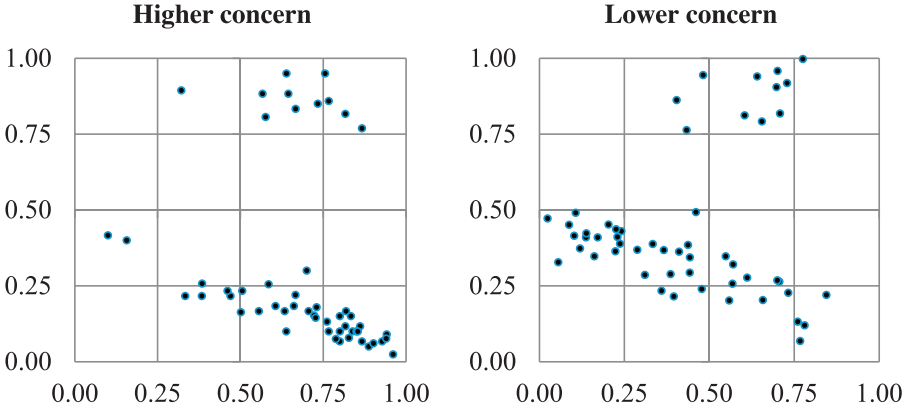

Fig. 2. The "valuation" (y-axis) and "priorization" (x-axis) of the 52 impacts of ASM in Madre de Dios, as rated by the participants of the first workshop. There are separate graphs for the clusters Higher concern and Lower concern. Each data point represents the average ratings for a specific impact. Moving up in the y-axis means more positive impacts and moving right means more urgent need for action to address a given impact. Data points (specific impacts) can be identified using the xy-values from the Supplementary material B.

concern) was formed by 12 participants, of whom nine were miners and the remaining three were representatives of the regional authorities. The other cluster (Cluster: Higher concern) was formed by 17 participants, including all six representatives of the civil society organizations, eight representatives of the authorities, and one miner. Fig. 2 shows a notable difference in how the distinct groups of actors presented the overall situation. The Lower concern cluster, as could be expected, tended to rate the impacts of mining as less problematic compared to the Higher concern cluster. In the case of particular impacts of mining, the differences between the clusters showed a more nuanced picture (Tables 1 and 2).

Both clusters showed a similar stance toward a number of impacts. For example, conflicts because of spatially overlaid property rights and the absence of the Peruvian State in the mining areas were rated as very negative impacts with a high level of urgency to be addressed. Other impacts, however, notably divided the two clusters. For example, whereas sexual exploitation, the exploitation of child labor, and organized crime were rated as highly negative impacts that needed urgent attention by the Higher concern cluster, the Lower concern cluster tended to rate them as low in importance. The same tendency was observed in relation to impacts that were related to the miners' working and living conditions.

4.2. Suggested solutions for impact management

In the second workshop, the five thematic groups proposed a variety of actions to be taken to manage the impacts of ASM in Madre de Dios. There were several remedies suggested to the conflicts arising from property rights. One suggestion was to manage all *spatial data* related to land-use and property rights in a single *information system* used in association with a system for *priority setting* in the different cases of overlaid rights. All this would be supervised by a multi-sectoral *conflict resolution body* with the faculty to mediate and make decisions in problematic and adversary situations.

In relation to the perceived absence of the Peruvian State authorities in the mining areas, the participants proposed, rather than a stronger presence of the central government, a decentralized process of formalization with a *mobile formalization office* that would move about in the mining areas also offering *capacity building*. This would require the regional government bodies to take a more proactive role and possibly the participation of trained miners as volunteers. The role of ASM in the generation of small and medium-sized enterprises in Madre de Dios was linked to the legal framework regulating the activity in the region. The participants called for *specific legislation* for alluvial gold mining to create a stable legal basis for the development of small and medium-sized enterprises directly in the field of ASM. The participants also emphasized the need for capacity building to strengthen mining-related *entrepreneurship*. This was tightly linked to a suggestion for an *in-depth assessment* of the ways in which ASM contributes to the generation of services and demand for products in the region, and, in general, to the regional economy and development. The formalization process, therefore, was presented as a larger endeavor including other sectors of society and economy.

The workshop participants also emphasized *technological development* in the ASM sector. First, in one of the working groups, it was suggested that a *technological framework* be developed that would take into account the specific social and environmental characteristics of alluvial mining. Second, so-called *pilot plants* were requested that would form the spearhead of the public involvement in the development of the ASM operations and the mining-related economy in general. With the participation of research institutions, non-governmental organizations (NGOs), and international cooperation, these centers of capacity building, technological development, and research-based education would also function as business incubators and platforms for project-based initiatives. They would also support the creation of a *regional geological laboratory* with the participation of national and regional research institutions.

The participants also discussed issues related to *labor informality* and *labor insecurity* as well as the *precarious state of health* and *education services* in the mining areas. One of the suggestions was to create a category of alluvial mining with labor security norms adequate for this kind of operation. The participants also proposed the creation of a *miner insurance system* to cover the cases of accident and illness related to this activity. Another proposal was the creation of a special fund for investment in health and education services in the mining areas. The funds would come from the contributions of the miners and the civil society.

Table 3
Activities suggested in the workshop #2 and included in the draft plan.

Type of impact	Suggested actions
Conflicts arising from overlaid property rights	1) Creation of a single spatial database including all land-use rights 2) Regional analysis of native communities 3) Creation of a priority scale for overlay situations 4) Establishment of a conflict-resolving body
Absence of the Peruvian State in the mining areas	1) Decentralized formalization process and a mobile formalization office 2) Active role for the regional government
Generation of small and medium-sized enterprises; diversification of the regional economy	1) Regional government proposes a separate law on alluvial mining 2) Evaluation of the necessity of capacity-building for the ASM sector entrepreneurs
Generation of services and demand for products in the region	1) Diagnostic study of the socio-economic role of ASM in Madre de Dios 2) Involvement of other sectors of economy in the formalization process 3) Regional government proposes a specific law for overall economic formalization
Technological development in the ASM sector	1) Evaluation of the norms about technologies permitted in alluvial mining 2) Implementation of pilot plants with trained miners 3) Creation of a regional mining laboratory
Labor informality and insecurity; precarious state of health and education services in the mining areas	1) Creation of the category of alluvial mining to boost the formalization process 2) Creation of a miner insurance for accident events
Alteration of water quality	1) Promotion of scaled sedimentation pools with filtering systems 2) Employment of the pilot plants for experiments in clean technologies 3) State agents back the concession holders to take efficient control of their concession areas

In relation to the alteration of water quality that the ASM operations create, the proposals included the development and promotion of better technologies, specifically through the pilot plants (e.g., gold extraction without mercury or the capture and recycling of mercury). Another important point brought forth was the application of scaled sedimentation pools with filtering systems in order for the mining operations to cause less turbidity in the waterways. The participants also stressed the importance of the support by the state agencies in enforcing the fulfillment of norms related to water quality.

The suggestions made by the working groups in the second workshop were compiled to form a basis for an agenda that would lead to the elaboration of a *social impacts management plan* to be implemented as part of or independently from the formalization process. We sent the draft agenda to the participants of the previous workshops prior to the third workshop. The plenary session organized in the third workshop resulted in the presentation of a draft for a social impacts management plan, developed on the basis of the activities proposed in the second workshop. An additional suggestion, not presented in the second workshop but discussed in the third, was the possibility to appoint a mediator to facilitate the impact management and formalization processes.

In practice, the draft plan listed and defined activities mentioned in the previous section on the results of the second workshop (Table 3). On a general level, there was also an agreement that such a plan should push forward four other goals related to the formalization process itself:

a To prevent and alleviate the possible negative impacts of formalization measures (e.g., loss of employment, transition of labor to illicit activities, displacement of the mining activities to unauthorized areas, and economic downturn in the region).
b To strengthen the positive impacts of formalization measures (e.g., improvements in the work security and conditions, reduction of sexual exploitation and exploitation of labor, increased payment of royalties and taxes, improved compliance with social and environmental norms, and better respect for land-use planning).
c To establish criteria for the acceptable and desirable impacts of the ASM activities.
d To guarantee the continuous and genuine participation of the different stakeholders in the formalization process through permanent dialogue and the institutionalization of social impacts management as part of good governance.

5. Discussion

5.1. Interests in mainstream formalization

Together with the workshop participants, we identified a number of social impacts of the ASM sector that either strongly divided or connected the interests of the different stakeholder groups taking part in the workshops (Tables 1 and 2). While views were shared over a number of positive and negative impacts of ASM in Madre de Dios, the participants of our workshops also perceived a wide gap between the formal policy purpose of the Peruvian government and the customs and practices of the ASM sector. These *gaps* appear where conflicting working rules, motivations, and purposes overlap (Hiedanpää et al., 2015) and where the ASM impacts are manifest and conflicts arise and are settled. Interestingly, the miners considered many ASM impacts related to their living and working conditions to be of lesser concern. This may be because miners in our workshops were mostly rights holders who may have different interests compared with their workers. This calls for further analysis.

Salman, (2016) has formulated the expectations of Bolivian gold miners in a way that, to our judgment, captures an essential feature of the Madre de Dios situation: “The will to work undisturbed.” However, this desire is disturbed by formalization that, while addressing property rights, does not necessarily pay as much attention to other rights, including human and political rights, even when abuses related to these rights are explicitly stated as reasons for formalization. This is exemplified by Putzel et al., (2015) when they list possible negative impacts of mainstream formalization. Policy failure may lead to economic loss and exclusion of vulnerable groups of humans, sometimes leading to criminalization and conflict. The adjusted institutional setup may also lead to new forms of *elite capture* of the resource and associated corruption. These processes can also generate environmental destruction when they trigger pre-emptive extraction or unforeseen dislocation of extractive activities. All of these risks could well materialize or have already materialized in Madre de Dios.

Intended mainstream formalization is not only about the control and mitigation of the adverse impacts of ASM but also very much about harnessing the positive contributions and *channelling benefit flows* toward politically chosen directions. However, the existing pre-formalization order of affairs already functions for this same end. A critical stance of many mainstream formalization processes builds on the argument that they are intended to propagate and amalgamate the interests of those holding power in resource use planning and decision making (Putzel et al., 2015). This is a strong case against top-down approaches and measures of implementation that are insensitive to local realities and contribute to non-democratic circumstances. Formalization is nevertheless often pursued as a control-oriented and information-intensive top-down endeavor (e.g. Salo et al., 2013; Putzel et al., 2015). Implementation of a *mobile formalization* office, as envisioned by the workshop participants, could help make the process more participatory and enable the inclusion of more local knowledge and information. This approach would also help implement education and capacity building activities among the different parties as a form of social impact management, something that has been suggested to be an important facilitating factor – if not a precondition – for ASM formalization (Veiga et al., 2014).

This kind of mesoscale approach – administration and the local mining-related actors working together in mobile formalization – would require a shared necessity for change, a purpose. Our data indicates that not only the treatment of the urgent matters of highly negative impacts of ASM in Madre de Dios but also the enhancement of the positive potential of mining could be a shared purpose. A central task is to articulate this shared purpose and implement measures to manage the impacts of ASM. The potentially positive role of mining may need to be addressed first so that there is a point of entrance. Conflicts characteristic to these processes are not only a sign of diverging interests but also manifestations of the different actors’ reactions to the formalization measures. Prenzel and Vanclay, (2014) are of the optimistic opinion that conflicts can be managed to inspire creative solutions and organizational change.

5.2. Motivation to act for the shared purpose

The current stalemate has left little room for creative bottom-up approaches and initiatives from the regional government of Madre de Dios. Vested interests, lack of political will, and a general distrust among the different actors characterize the current *cul-de-sac*. The weak state apparatus also at times is co-opted by actors representing mining interests, as evidenced by a miner elected as the regional president (governor) of Madre de Dios in 2014 (Damonte, 2016). The attempted mainstream formalization

process suffers not only from these hindrances but it is also short of ideas on how to establish concrete ties between the steps of *formalization and the impacts* that they address. Unveiling the interests in ASM and making them tangible is essential for attempts to address the impacts of mining, were it through mainstream formalization or other approaches. Our workshop results offer advice of how to unfold such analysis and how to operationalize the findings.

The overt purpose of the Peruvian government has been to gain the control of the ASM activity, generate public revenue, and implement and enforce social and environmental norms. These are legitimate goals for any government. The formalization of ASM in Madre de Dios is an example of how a mainstream formalization process can be portrayed alternatively as a means to reform an economic activity and empower marginalized actors or as a way to control and punish them, sentencing many to illegality in the face of regulations impossible to comply with. These kinds of ambiguous outcomes of many top-down formalization processes have made it tangible how these processes disturb an existing customary order. This situation has been prevalent, for example, in the Peruvian forest sector reform (Salo et al., 2013). In this sense, the problems faced by the formalization process are due to the limitations of the Peruvian state's capacity to govern (Damonte, 2016). Moreover, the mining sector is not composed of poor marginalized subsistence miners alone, but rather is a network of relatively affluent actors (Damonte, 2016), tightly linked to investors, suppliers, gold shop owners, and processing key owners that may see even less to gain in a formalization process. In this context, the formalization process has not been able to lean on the existing or to create new interpretative communities in its support (Mosse 2004; Igue and Fortwangler, 2007).

ASM activities are an inherent part of the socio-economic and political fabrics of Madre de Dios, with both positive and negative impacts, and the way forward may need to be the acceptance of this state of affairs. The workshops showed that there is a prospect for dialogue and for a continuous yet conflict-driven process of governing and managing impacts in collaboration. One of the problems is that there are no powerful corporations or regional elites with whom the negotiation could be carried out using the means currently in use (Damonte, 2016). The situation makes active stakeholder collaboration that builds also on the resourcefulness of the miners all the more important in relation to simple dialogue or consultation (Franks and Vanclay, 2013). While there are miners' groups that may not be motivated to cooperate, others clearly saw the benefits of being a legitimate partner in collaboration instead of a passive recipient of formalization ideas and measures (Damonte, 2016). This became apparent in our workshops.

Mediation is a voluntary, negotiation-based conflict resolution process with a long history (Amy, 1987), and it has recognized potential in ASM-related conflicts (Andrew, 2003). In our case, the identity of a possible mediator was, with hindsight unfortunately, not discussed in depth in the workshops. Finding a suitable mediator with a keen knowledge of the local context who is trusted by all parties is not straightforward. A mediator initially considered impartial may soon be seen as biased. In the Peruvian mining sector, the state ombudsman's office has offered mediation and, even with its mixed results (Bebbington and Bury, 2009; Triscritti, 2013), we consider it a viable option. Other possible profiles for the mediator should be considered, including academics and external consultants.

Our workshops generated a broad conclusion that a possible first step in the case of Madre de Dios could be the simultaneous appointment of a *regional mediator* with a strong mandate, the establishment of a *mobile formalization office,* and the implementation of a series of coordinated but independent impact management activities through an *impact management plan*. The draft plan sketched in the workshops only presented rough guidelines of where to proceed in the management of the impacts of ASM in Madre de Dios. What is needed is the design and implementation of concrete actions with clearly defined responsibilities motivating the miners, the rest of the civil society, and the state government and its administration to continuous collaboration.

6. Conclusion

In Madre de Dios, the ASM conflict periodically bursts into a violent confrontation and then returns to a latent state. In the face of the mainstream formalization process, the ASM actors have shown how to resist, adapt, and organize their lives and work while trying to cope with the social impacts of mining. What the process of formalization brings in is only one factor in the disturbance. In short, formalization has failed to offer clear benefits to the ASM actors. As our workshops showed, there are miners who are open to discussions about the needed changes. In our view, these actors should be directly involved through a participatory impacts management process offering practical benefits, including versatile capacity building. This would be parallel with or prior to any possible further formalization process.

Mesoscale collaborative approaches to impact management form a complementary strategy to the mainstream formalization. State-imposed and enforced norms and policies are part of the solution, but locally designed and implemented measures to manage the social impacts of ASM are needed. This means that the bureaucratic processes must become under review: the success of mainstream formalization should not be seen as a prerequisite to – much less a synonym of – dealing with the impacts. A process of impact management from below also differs from a mainstream top-down formalization process in that it would not establish a stepwise procedure in which the failure to achieve one goal would block the pursuit of others. This is how progress would be possible in many fronts at once, even if some goals turned out to be difficult to reach.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.exis.2016.10.001.

References

Alvarez-Berríos, N.L., Aide, T.M., 2015. Global demand for gold is another threat for tropical forests. Environ. Res. Lett. 10 (1), 014006.
Amy, D., 1987. The Politics of Environmental Mediation. University Press, New York: Columbia.
Andrew, J.S., 2003. Potential application of mediation to land use conflicts in small-scale mining. J. Clean. Prod. 11 (2), 117–130.
Ashe, K., 2012. Elevated mercury concentrations in humans of Madre de Dios, Peru. PloS One 7 (3), e33305.
Asner, G.P., Llactayo, W., Tupayachi, R., Luna, E.R., 2013. Elevated rates of gold mining in the Amazon revealed through high-resolution monitoring. Proc. Natl. Acad. Sci. 110 (46), 18454–18459.
Batista, G.E.A.P.A., Monard, M.C., 2001. A Study of K-Nearest Neighbor as a Model-Based Method to Treat Missing Data. Proceedings of the Argentine Symposium on Artificial Intelligence (ASAI'03), vol. 30. Buenos Aires, Argentina, pp. 1–9.

Bebbington, A.J., Bury, J.T., 2009. Institutional challenges for mining and sustainability in Peru. Proc. Natl. Acad. Sci. 106 (41), 17296–17301.
Berthelot, J., 1986. The extraction of precious metals at the time of the Inka. Anthropol. Hist. Andean Polities 69–88.
Brack, A., Ipenza, C., Álvarez, J., 2011. Informe Sobre Minería Aurífera En Madre De Dios Y Contaminación Con Mercurio -una Bomba De Tiempo. Ministerio del Ambiente, Departamento de Investigación, Lima.
Bromley, D.W., 2006. Suffificient Reason: Volitional Pragmatism and The Meaning of Economic Institutions. Princeton University Press, Princeton.
Bromley, D.W., 2009. Formalising property relations in the developing world: the wrong prescription for the wrong malady. Land Use Policy 26 (1), 20–27.
Chavez, A.B., Perz, S.G., 2013. Path dependency and contingent causation in policy adoption and land use plans: the case of Southeastern Peru. Geoforum 50, 138–148.
Damonte, G., Bueno de Mesquita, M., Hugo Pachas, V., Chávez Quijada, M., Flores, A., De Echave Cáceres, J., 2013. Small-scale gold mining and social and environmental conflict in the Peruvian Amazon. In: Cremers, L., Kolen, J., de Theije, M. (Eds.), Small-scale Gold Mining in the Amazon. The Cases of Bolivia, Brazil, Colombia, Peru and Suriname. Cedla, Amsterdam.
Damonte, G.H., 2016. The blind state: government quest for formalization and conflict with small-scale miners in the Peruvian Amazon. Antipod. Early View doi:http://dx.doi.org/10.1111/anti.12230.
Defensoría del Pueblo, 2014. Informe Defensorial N° 167: Balance de la gestión estatal frente a la Minería Informal e Ilegal en el Perú, 2012–2014, supervisión a las entidades de alcance nacional y regional, July 2014, Lima, Peru.
Elmes, A., Yarlequé Ipanaqué, J.G., Rogan, J., Cuba, N., Bebbington, A., 2014. Mapping licit and illicit mining activity in the Madre de Dios region of Peru. Remote Sens. Lett. 5 (10), 882–891.
Fish, S., 1989. Doing What Comes Naturally: Change Rhetoric and the Practice of Theory in Literary and Legal Studies. Duke University Press, Durham.
Franks, D.M., Vanclay, F., 2013. Social impact management plans: innovation in corporate and public policy. Environ. Impact Assess. Rev. 43, 40–48.
GOREL, 2011. Plan de Formalización y Reconversión de la Minería en Madre de Dios. Gobierno Regional de Madre de Dios. Comisión Especial −RER −RER N° 103–2011-GOREMAD/PR, Puerto Maldonado, Peru.
Geenen, S., 2012. A dangerous bet: the challenges of formalizing artisanal mining in the Democratic Republic of Congo. Resour. Policy 37 (3), 322–330.
Grönlund, K., Herne, K., Setälä, M., 2015. Does enclave deliberation polarize opinions? Polit. Behav. 1–26.
Hammond, D.S., Gond, V., Thoisy, B.D., Forget, P.M., DeDijn, B.P., 2007. Causes and consequences of a tropical forest gold rush in the Guiana Shield, South America. AMBIO: J. Hum. Environ. 36 (8), 661–670.
Hiedanpää, J., Salo, M., Kotilainen, J., 2015. Teleodynamics and institutional change: the hardship of protecting the Amur tiger, big leaf mahogany, and grey wolf. J. Nat. Conserva. 26, 36–44.
Hilson, G., McQuilken, J., 2014. Four decades of support for artisanal and small-scale mining in sub-Saharan Africa: a critical review. Extr. Ind. Soc. 1, 104–118.
Hilson, G., Hilson, A., McQuilken, J., 2016. Ethical minerals: fairer trade for whom? Resour. Policy 49, 232–247.
Hilson, G., 2010. Child labour in African artisanal mining communities: experiences from Northern Ghana. Dev. Change 41 (3), 445–473.
Igoe, J., Fortwangler, C., 2007. Whither communities and conservation? Int. J. Biodivers. Sci. Manag. 3, 65–76.
Jeronimo, R.P., Rap, E., Vos, J., 2015. The politics of land use planning: gold mining in cajamarca Peru. Land Use Policy 49, 104–117.
Kohavi, R., 1995. A Study of Cross-validation and Bootstrap for Accuracy Estimation and Model Selection. Proceedings of the Fourteenth International Joint Conference on Artificial Intelligence. Morgan Kaufmann, San Mateo, pp. 1137–1143.
Labonne, B., 2014. Who is afraid of artisanal and small-scale mining (ASM)? Extr. Ind. Soc. 1 (2), 121–123.
Linares, L.A., 2010. Informal economy budget analysis in Peru and metropolitan Lima: women in informal employment: globalizing and organizing (WIEGO). Work. Pap. 13.
Mosse, D., 2004. Is good policy unimplementable? reflections on the ethnography of aid policy and practice. Dev. Change 35 (4), 639–671.
Oyola Valencia, M., 2014. Superposición de derechos adquiridos. Presentation at the seminar Presentación del libro Implicancias de la Minería Informal Sobre la Salud de Mujeres y Niños en Madre de Dios, 5th of November 2014, Puerto Maldonado, Peru.
Pelleg, D., Moore, A., 2000. X-means: extending K-means with efficient estimation of the number of clusters. Proc. Seventeenth Int. Conf. Mach. Learn. 2000.
Prenzel, P.V., Vanclay, F., 2014. How social impact assessment can contribute to conflict management. Environ. Impact Assess. Rev. 45, 30–37.
Putzel, L., Kelly, A.B., Cerutti, P.O., Artati, Y., 2015. Formalization as development in land and natural resource policy. Soc. Nat. Resour. 28 (5), 453–472.
Salman, T., Carrillo, F., Soruco, C., 2015. Small-scale mining cooperatives and the state in Bolivia: their histories, memories and negotiation strategies. Extr. Ind. Soc. 2 (2), 360–367.
Salman, T., 2016. The intricacies of being able to work undisturbed: the organization of alluvial gold mining in Bolivia. Soc. Nat. Resour. 29 (9), 1124–1138.
Salo, M., Puro, J.P., Knuuti, K., 2013. Control and intimacy in the Amazonian reality: newspaper rhetoric on forest sector reform in Peru. Land Use Policy 35, 226–236.
Seccatore, J., Veiga, M., Origliasso, C., Marin, T., De Tomi, G., 2014. An estimation of the artisanal small-scale production of gold in the world. Sci. Total Environ. 496, 662–667.
Siegel, S., Veiga, M.M., 2009. Artisanal and small-scale mining as an extralegal economy: de Soto and the redefinition of formalization. Resour. Policy 34 (1), 51–56.
Spiegel, S.J., 2012. Governance institutions, resource rights regimes, and the informal mining sector: regulatory complexities in Indonesia. World Dev. 40 (1), 189–205.
Swenson, J.J., Carter, C.E., Domec, J.C., Delgado, C.I., 2011. Gold mining in the Peruvian Amazon: global prices, deforestation, and mercury imports. PLoS One 6 (4), e18875.
Triscritti, F., 2013. Mining, development and corporate-community conflicts in Peru. Comm. Dev. J. 48 (3), 437–450.
Vallejo Rivera E., 2014. Implicancias de la minería informal sobre la salud de mujeres y niños en Madre de Dios Sociedad Peruana de Derecho Ambiental: Lima, Peru.
Veiga, M.M., Angeloci-Santos, G., Meech, J.A., 2014. Review of barriers to reduce mercury use in artisanal gold mining. Extr. Ind. Soc. 1 (2), 351–361.
Verbrugge, B., Besmanos, B., 2016. Formalizing artisanal and small-scale mining: whither the workforce? Resour. Policy 47, 134–141.
Virtanen, V.-V., 2014. Hienojakoisen kullan esiintyminen Amazonian Madre de Dios jokilaakson kvartäärikauden jokisedimenteissä. LuK-tutkielma. Turun yliopisto, Maantieteen ja geologian laitos.
Yard, E.E., Horton, J., Schier, J.G., Caldwell, K., Sanchez, C., Lewis, L., Gastañaga, C., 2012. Mercury exposure among artisanal gold miners in Madre de Dios, Peru: a cross-sectional study. J. Med. Toxicol. 8 (4), 441–448.
de Soto, H., 2000. The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else. Basic Books, NewYork.
Yusuff, O.S., 2011. A theoretical analysis of the concept of informal economy and informality in developing countries. Eur. J. Soc. Sci. 20 (4), 624–636.